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NANOFIBRE NON-WOVENS OF KERATIN/POLYAMIDE 6 BLENDS FOR HIGH EFFICIENCY ACTIVE-FILTRATION

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The pooling and processing of protein wastes currently disposed, such as fibre by-products from the wool textile industry, low-quality raw wools from breeding, horns, nails and feathers from butchery, would allow the production of innovative bio-plastics suitable for novel large-scale uses (compostable films for agriculture and packaging, filaments for textiles, sanitation and filtration [1]). Moreover, since it is known that keratinous materials can absorb toxic substances such as heavy-metal ions [2], formaldehyde and other hazardous volatile organic compounds [3], applications can be envisaged also in water purification and air cleaning by active-filtration. Literature data show that 1 g keratin binds 450 μmol formaldehyde at pH 7, 20 °C for 48 h [4].

However, the poor mechanical properties of regenerated keratin restrict processing and practical applications to blends with appropriate polymers with better structural properties [5, 6].

In the present work, keratin was extracted from wool and blended with polyamide 6 in formic acid as the co-solvent, in order to obtain blend solutions suitable for electrospinning. Keratin-based nanosized fibre mats were produced and tested for heavy metal removal from water solutions.

Keratin was obtained from wool by sulfitolysis with m-bisulfite (0.5M), urea (8M) and sodium dodecyl sulfate (SDS, 0.05M) at pH 6.5 with 5N NaOH; then dialyzed against distilled water for 3 days and regenerated by casting at 50 °C overnight.

Regenerated keratin and polyamide 6 were blended in formic acid in different weight proportions (0/100, 10/90, 30/70, 50/50, 70/30, 90/10, 100/0), total concentration 15% w/w.

A preliminary study was conducted on films produced by casting, in order to investigate the miscibility of keratin with polyamide 6 in different proportions. Successively, blend solutions were characterized by viscosity measurements and then electrospun under different operating conditions. Fibre morphology and diameter distributions were correlated with the blending ratios. Moreover, the influence of keratin amount and the processing method (cast or electrospinning) on the supramolecular organization of the polyamide 6 chains was studied.

The absorption of heavy metal ions from diluted solutions was evaluated by immersion of the keratin/PA 6 90/10 mat sample in an aqueous solution of Cr^{3+} (15 $\mu\text{g/l}$) and compared with the pure PA 6 sample, because of their good stability in water.

The removal of Cr^{3+} ions as a function of the contact time was analysed by Atomic Absorption Spectrometer: a little amount of keratin (10% wt) was enough to obtain chromium adsorption 35% higher than that of pure PA6, even after a 40 minutes treatment. This suggests the high ability of keratin to steadily uptake chromium. Metal removal by keratin occurs by a combination of two events: the trapping of metal ions in the nano-porous structure in the keratin network (physiosorption) and the chemical (coordinative) bonding between metal ions and carboxylic group sites of the protein (chemisorption). It is also worth noting that higher contact time favoured a steady increase in the chromium removal.

The keratin based porous materials are promising candidates for active air cleaning and removal of heavy metals from contaminated-water.

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